10. DEATH BY COLD OF FISH IN THE RIVER GANDAK, INDIA

Though several natural and artificial causes of fish mortality in rivers are known (Klein 1957), instances of fish getting suddenly numbed in a section of a fluviatile habitat, apparently caused by sudden lowering of water temperature, appear to be unknown in India. The phenomenon of 'cold shock' is, however, well known throughout Europe and N. America. Rounsefell & Everhart (1953) speak of some 'warm water fish' in ponds becoming powerless to move and of coastal fish dying during sudden cold spells. While engaged in fisheries survey in the vicinity of the proposed Gandak barrage near Bhaisalotan, north Bihar, the authors observed a case of large-scale numbing and surfacing of fish at the barrage site on 5-3-1962, occasioned by sudden intense hailstorms. The phenomenon observed, with its probable cause, is presented in this note.

The River Gandak, originating in the high Himalayan ranges of central Nepal, passes through precipitous gorges before emerging into the plains, a short distance above the proposed barrage site at Bhaisalotan, which lies on the left bank of the river in the Indian territory. The incidence of distress among fish was observed in about 1.5-2.0 m. deep, two mile long stretch of the smaller left fork of River Gandak which joins its main right diversion a little further downstream. Sonapancha, a small tributary, joins the Gandak on the left bank just above the bifurcation mentioned above, bringing in considerable torrential flow after every precipitation, which mostly drains off along the left channel at the foot of Bhaisalotan.

Prior to the precipitation accompanied by two hailstorms on 5-3-1962, the rubble-studded, sandy river-bed, close to Bhaisalotan, had very clear, gently flowing water and an abundant growth of filamentous algae (*Spirogyra* sp.) with many boulder-lined shelter pools, and considerable congregation of fish was noticed at that site in the river in general and in the shelter pools in particular.

Hailstorms accompanied by heavy rain visited the site twice on 5-3-1962, first at 10 a.m. and next at 11 a.m., the former lasting half-an-hour and the latter, the more intense one, for about 45 minutes, carpeting the ground at places with about 10 cm. deep hailstones. The temperature of the left fork of the Gandak was 18.20° C. prior to the first downpour, which lowered the temperature to 17° C. The second spell of rain and hail, however, suddenly lowered the temperature of the Sonapancha to 5° C., the cold waters of the tributary in turn reducing the temperature of the left branch of Gandak to 6.5-7° C.

within a short time. Soon after the water got suddenly chilled, hundreds of fish surfaced appearing stunned and dazed and showing signs of deep distress, though none appeared to be dead. Well over a hundred villagers and labourers, shortly thereafter, gathered on both the banks of the channel to take a rather effortless catch of fish with impromptu fish-catching devices like hand and scoop nets and sheets of cloth of various dimensions. Many held sticks and bamboo poles in their hands to beat and capture some semi-stunned fish. Later, some small fishing nets were brought and the hauls were made somewhat more systematically. This fishing activity continued for about an hour and about 1000 kilograms of fish were collected. The species composition of the affected fish, stated in the order of decreasing frequency of occurrence is given in Table I:

TABLE I

SPECIES OF FISH AFFECTED BY THE CHILLING OF WATER

Major species	Minor species
1. *Wallago attu* (Bl. & Schn.)	1. *Oxygaster gora* (Ham.)
2. *Mystus* (*Osteobagrus*) *seenghala* (Sykes)	2. *Aspidoparia morar* (Ham.)
3. *Mystus* (*Osteobagrus*) *aor* (Ham.)	3. *Osteobrama cotio cotio* (Ham.)
4. *Labeo gonius* (Ham.)	4. *Mystus* (*Mystus*) *cavasius* (Ham.)
5. *Ompok bimaculatus* (Bloch)	5. *Mystus* (*Mystus*) *vittatus* (Ham.)
6. *Cirrhina mrigala* (Ham.)	6. *Puntius sophore* (Ham.)
7. *Puntius sarana* (Ham.)	7. *Puntius ticto ticto* (Ham.)
8. *Labeo rohita* (Ham.)	8. *Glossogobius giuris* (Ham.)
9. *Labeo bata* (Ham.)	9. *Crossocheilus latius latius* (Ham.)
10. *Channa striatus* (Bloch)	10. *Barilius barila* (Ham.)
11. *Channa marulius* (Ham.)	11. *Rasbora daniconius* (Ham.)

Water samples from four different spots in the affected zone were promptly collected to draw a picture of the physico-chemical conditions of the river at the time when the fish were displaying distress, for comparison with those obtaining in the stream normally. Table II presents the salient physico-chemical characters of the river as on March 2-3 and on March 5, 1962, the latter during the actual period of fish distress.

From the foregoing account it is seen that a sudden sharp fall of 11.7° C. in the water temperature occurred in the affected zone of River Gandak prior to fish displaying distress. The pH value registered a fall from 8.3 to 7.5 with carbon dioxide concentration rising from *nil* to 30 p.p.m. Turbidity rose from *nil* to 2500 p.p.m. and the specific conductivity decreased from 290 to 93 mho. Ammonia appeared in traces (0.05 p.p.m.) where there was none before.

TABLE II

PHYSICO-CHEMICAL CONDITIONS OF THE LEFT GANDAK CHANNEL*

	Diurnal variations before the hailstorm on 2-3rd March 1962								During actual period of distress on 5-3-62
	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.	1 a.m.	4 a.m.	
1. Water temp. (in °C.) ..	18.1	19.5	22.3	22.9	21.0	20.1	19.0	18.2	6.5–7.0
2. Turbidity ..	C l e a r W a t e r								2,500
3. pH ..	8.3	8.4	8.5	8.6	8.5	8.5	8.4	8.3	7.5
4. Dissolved oxygen (D.O.)	7.4	8.2	9.6	9.6	8.3	7.7	7.6	7.4	8.7
5. Free CO_2 ..	0	0	0	0	0	0	0	0	30
6. Hardness ..	—	144	—	—	—	—	—	—	80
7. Specific conductivity ($\times 10^{-6}$ at 25°C.): in mho.	—	290	—	—	—	—	—	—	93
8. Alkalinity ..	—	116	—	—	—	—	—	—	48
9. Chloride ..	—	7.5	—	—	—	—	—	—	40
10. Oxygen consumption ..	—	8.0	—	—	—	—	—	—	25
11. Free ammonia ..	0	0	0	0	0	0	0	0	0.05

* Results expressed in parts per million except where stated otherwise

Apart from metallic contaminants, poisonous gases, and other toxic substances which are lethal to fish when released generally with trade and domestic effluents, the natural factors which cause fish distress, and at times mortality, are low dissolved oxygen, high carbon dioxide concentration, presence of ammonia, and extraordinarily high turbidity. The dissolved oxygen value of 8.7 p.p.m. noted at the time of distress was sufficiently high (higher than normal) and, therefore, the question of considering this factor as a cause of distress does not arise, specially when, at the prevalent low temperature, the metabolic processes of fish must necessarily have been physiologically retarded. Carbon dioxide at concentrations up to 30 p.p.m., in the absence of ammonia, does not prove lethal to fish even if there is a 12 hour exposure, as observed by Alabaster & Herbert (1954). Further, any higher carbon dioxide concentration (up to 60 p.p.m.) serves only to reduce the toxicity of ammonia. Alabaster & Herbert (op. cit.) have further observed that lowering of pH value is a vital, if not the only, cause of reduction of toxicity of ammoniacal solutions. In the observation reported here, the pH recorded was 7.5, ammonia 0.05 p.p.m., and carbon dioxide 30 p.p.m. Since fish distress was observed an hour or so after the cessation of rain, the probability of either carbon dioxide or ammonia being responsible for the phenomenon is perhaps negligible. The sudden change in turbidity from clear water to as high as 2500 p.p.m. might have caused a certain degree of impediment to the functioning of the fish gills. Even this may not be tenable as a cause for fish distress since, in such a case, the fish could have easily escaped into comparatively clear water areas further downstream. Besides, it has been observed by one of the authors (A.D.) that in some of the larger rivers of the Ganga river system, turbidity values during monsoon floods normally rise up to 2000 p.p.m. and values even as high as 5000 p.p.m. are recorded in the Ganga, but fish distress at such times is not known to occur. A turbidity of 6000 p.p.m. in Potomac river, recorded by Kemp (1949), did not prove harmful to fish. Higher values, however, may be dangerous after a prolonged exposure (Herbert & Merkens 1961). As pointed out by Kemp (op. cit.) a turbidity of 3000 p.p.m. is considered dangerous to fish when maintained over a 10-day period. In laboratory experiments with trout, Herbert & Merkens (op. cit.) observed that solid concentration, when raised intermittently by hand stirring to 10,000 p.p.m., did not cause any mortality, and the fish finally died only when concentrations were raised to 175,000 p.p.m. and beyond. These lethal turbidities caused death within 2 hours of exposure. Griffin *et al.* (1945) observed that fish withstand turbidities from 300 to 6500 p.p.m. However, a much higher value of 20,000 p.p.m. caused by wood fibres was recorded by Cole (1955), when healthy fish did not die. In the present case the absolute value of turbidity was well within the tolerance limit but may have contributed to fish distress because of its sudden appearance.

The water temperature, which normally varied between 18.1 and 22.9° C. during a 24 hour period on 2-3rd March 1962, and the early morning temperature of 18.20° C. recorded on the same day came down to as low as 6.5-7° C. within a couple of hours, probably directly affecting the nervous system of the fish and numbing or paralysing their musculature. As a result, the fish became stunned, lost their normal capacity to swim, and floated helplessly in the chilly waters.

All the victims listed in Table I, are warm-water forms which inhabit the middle and lower reaches of north Indian rivers where the water temperature in summer months reaches up to 32° C. Though cold-water forms like *Tor* sp. (Mahseers), *Lissocheilus hexogonolepis* (Katli Mahseer, *Bagarius bagarius* (the 'Goonch'), several species of *Glyptothorax*, several species of *Barilius*, *Danio* sp., *Garra* sp., *Labeo dyocheilus*, *L. dero*, and others are known to be present in the river, as revealed by a fish survey (David 1963), not a single specimen showed distress and surfaced at the time when the fish listed were exhibiting distress. This observation lends support to the contention that the main cause of the numbing and distress among fish, reported here, was the sudden lowering of water temperature from 18.2° C. to 6.5° C.

In India little work has been done, so far, to demarcate accurately the geographic distribution of economic species of fish according to the temperature gradients which prevail in streams and rivers of the country. The degree of temperature tolerance and preference of some fish relative to their surrounding media are still to be experimentally elucidated for a proper understanding of the hydrographic factors involved. The subject has at the present juncture assumed great importance especially in the context of the urgent need to develop the high altitude fisheries of the Himalayan region.

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11. DEATH BY COLD OF COMMERCIAL CARPS IN DELHI

Large-scale mortality of commercial carps in the Government-owned nursery tank in Shahadra during the latter part of December 1961 when Delhi experienced a severe cold forms the subject matter of the present communication.

The Shahadra nursery tank is a rectangular pond with an area of about half acre and an average depth of 5 feet during the monsoon. In summer its water level falls rapidly and the tank dries up in June. It has a luxuriant growth of *Potamageton pectinatus* Linnaeus and *Vallisneria spiralis* Linnaeus.

The mortality occurred during the period 18-12-1961 to 26-12-1961 in the early hours between 3-7 a.m. About 5000 fingerlings of the major carps ranging from 40-60 mm. were estimated to have been killed. In addition, a large number of other fishes were noticed in distress. The estimated percentage of dead fishes is given in Table I.

TABLE I

Species	Local name	Percentage mortality
1. *Catla catla* (Hamilton)	Catla	28%
2. *Labeo rohita* (Hamilton)	Rohu	27%
3. *Labeo bata* (Hamilton)	Bata	5%
4. *Labeo calbasu* (Hamilton)	Kalbons	3%
5. *Cirrhina mrigala* (Hamilton)	Mrigal or Narain	35%
6. *Cirrhina reba* (Hamilton)	Reba	2%